

DARLINGTON (T.) *With the Compliments
of the Author.* *abl*

The Effect of the Products of
High Explosives, Dynamite
and Nitro-Glycerine, on
the Human System

BY

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ETY OF THE COUNTY OF NEW YORK; FORMERLY SURGEON
TO THE NEW CROTON AQUEDUCT, ETC.

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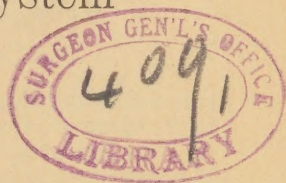


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THE EFFECT OF THE PRODUCTS OF HIGH EXPLOSIVES, DYNAMITE AND NITRO-GLYCERINE, ON THE HUMAN SYSTEM.

IN the construction of any work of magnitude, in the present day, involving the removal of rock, dynamite or nitro-glycerine is used in considerable quantities.

When these are used in open cut-work, as on railroads, after the explosion the gases immediately distribute themselves in the atmospheric air, and no effect has been noticed on the workmen employed.

But where it is used in tunnels, as in mining or other partially closed cavities, and the gases or residue are slow to escape from the mouths of the tunnel, or up an air-shaft, serious deleterious effects are produced.

Dynamite is composed of nitro-glycerine with some absorbent. There are, for purposes of study, practically two classes of dynamite, which might be termed inorganic and organic, according to the absorbent used. As a type of one class is that made with infusorial earth—Kieselguhr—which is composed of siliceous diatoms, and of the other, that made with ground wood-pulp, or sawdust. Others, still, are made from a combination of both kinds. The results of the explosion, however, are practically the same in either case, except with the organic absorbent we get with the products an additional amount of carbon.

An experience of over five years where such explosives have been in use, and as yet not having read any article on this subject, have led me to believe that one might be of interest to some of the profession.

During 1885 to 1887, while surgeon to the New Croton Aqueduct, fully thirteen hundred cases of asphyxia, or par-

tial asphyxia, and poisoning, from the products resulting from the explosion of dynamite, came under my care; and more recently a few other cases which I have had a better opportunity to study.

Two classes of cases were observed: First, where a considerable quantity of the products was inhaled at one time—acute cases; secondly, where the men constantly breathed a small amount, or chronic cases. The acute cases varied according to the amount inhaled.

In some cases where the amount of dynamite used is not large, or where after the explosion a considerable quantity of fresh air has been mixed with the products of combustion, or where the workman has, after a few breaths, become giddy, and is pulled away by others and sent to the surface, the effects produced are a trembling sensation, flushing of the face, succeeded sometimes by pallor, frequently nausea, sometimes vomiting, with throbbing through the temples and fulness in the head, as if it would burst, followed by an intense headache characteristic of poisoning by nitrites—similar to that of nitrite of amyl—only not so violent, but more persistent, frequently lasting forty-eight hours. The heart's action is increased, and the pulse full and round, though somewhat compressible.

CASE I.—J. C——, occupation, miner, while returning to work after a blast, became dizzy, and crawled on hands and knees back to the bucket; felt as if drunk. About twenty minutes afterward was nauseated and vomited slightly. Had a feeling as if his head was swelled. After vomiting the headache increased. The pulse at this time was full and bounding, and 108. Ten hours afterward the headache was more pronounced, and the pulse 88 and more compressible.

Where, however, a man goes into the tunnel immediately after the explosion, and is brought in contact with a large percentage of the poisonous materials, the effects are giddiness immediately followed by unconsciousness, and the patient presents the usual appearance of asphyxia.

Sometimes in these cases the pulse is full and bounding, though very compressible ; but in most of the cases it is alarmingly weak. Generally there is great pallor, though this may be partially due to working underground. The comatose condition soon passes away, and is succeeded by drowsiness, languor, cold perspiration, intermittent pulse, and generally nausea and vomiting. Sometimes the breathing is spasmodic, and frequently there is hiccough, and after a time a severe headache.

Nearly all of these cases, however, no matter how serious they seem at the time, recover ; though a substitute on the Aqueduct, during my absence, was on one occasion so unfortunate as to lose two cases. I found upon inquiry that death in these cases occurred several hours after the patients were removed from the tunnel, and was due to paralysis of respiration.

In the chronic cases there are four prominent symptoms : Headache, cough, indigestion, and disturbances of the nervous system.

The cough is similar in character to the cough of pertussis or of malaria, and at first I was under the impression that it was purely malarial, as cases of intermittent fever were frequent. But although some of the cases may have been complicated with malaria, there were many others that were not, in which the cough was persistent.

In nearly all of the cases there was a continuing headache.

Next in prominence to these symptoms come disturbances of the nervous system, as trembling, irritability, neuralgia, etc. In fact, nearly if not all of the symptoms were attributable to this cause. Even the cough, in all probability, was due to the effect produced on the pneumogastric nerve.

One of the superintendents became so nervous and irritable, largely from this cause, that it was with difficulty that he could get along with the men. All of the men affected seemed extremely nervous. And with this was associated indigestion, probably due to the same cause.

Of course, with this latter symptom, the character of the food and the manner in which it was eaten must be taken into consideration. But as soon as a man with these chronic symptoms was taken from the tunnel and placed at work on top, he steadily improved, and would finally recover entirely.

It was also noticeable that those who had previously suffered from dyspepsia or neuralgia were made much worse by the dynamite smoke.

One inspector on the Aqueduct was forced to resign by reason of the constant return of an old "tic douloureux," due to this cause. What were the symptoms recognized due to?

The formula for nitro-glycerine is $C_3H_5(NO_3)_3$. And the products from the combustion of this written: $4(C_3H_5N_4O_9) = 10(H_2O) + 12(CO) + 6(N_2O_2) + O_2$.

In other words, the products are water, carbonic oxide, and nitrogen dioxide; none of which would produce the symptoms above described except asphyxia, but not the effect on the heart, nor the other symptoms witnessed. What, then, was the cause?

A comparison of the above symptoms in the acute cases with the phenomena produced by various-sized doses of nitro-glycerine shows them to be identical. This similarity of symptoms from inhalation of the products of the explosion of dynamite, and of those produced by the nitro-glycerine itself, is so well marked that even miners themselves have noticed it. Frequently, when dynamite is frozen a miner will place a cartridge in his boot to thaw it out; and the absorption of nitro-glycerine through the skin will produce precisely the same symptoms as in the mild acute cases of the inhalation of the products before described.

Again, I know an instance of where a miner used his knife to cut a cartridge, and afterward cut and ate an apple with the same knife. In this case, according to his statement, the symptoms were similar to being "knocked out by powder smoke," only more severe. The headache

persisted three weeks. And on another occasion this same miner cut up some tobacco to smoke with a knife that he had used for dynamite, and was again similarly affected. Here the heat from the tobacco inhaled smoke volatilized the fine particles of nitro-glycerine on the tobacco below, and poisoning was produced by absorption through the lung tissue.

No other conclusion can well be reached than the fact that there is mixed with the gases produced unexploded particles of nitro-glycerine in a volatile state; and these particles inhaled by the miners produced the effect described.

This fact can be conclusively proved by waving in the fumes, immediately after an explosion, a cold sheet of glass, and thus collecting upon it by condensation a small percentage of the nitro-glycerine itself.

There is no doubt but that the explosion of a large quantity of dynamite would produce sufficient gases of CO and N_2O_2 to produce asphyxia. Here we get the cyanosis and other symptoms of simple asphyxia, and we may get nausea and vomiting; but not the same disturbance of the sympathetic system, nor the continued chronic spasms of the vagus, nor the persistent headache pathognomonic of nitro-glycerine poisoning.

As regards treatment—as a preventive the use of such apparatus or machinery, whether by blowing or by sucking, that will rapidly clear the tunnel or cavity from noxious gases or fumes is to be recommended. Where steam drills that are worked with an air compressor are used, they contribute largely to this end.

Also, it has been found by makers of dynamite that the use of a large cap will explode a greater percentage of the glonoine than a small one, and this, to a certain extent, obviates the trouble. In certain cases, however, for some reason, a cartridge does not explode, but burns like a candle, with considerable spluttering. In such an instance the amount of nitro-glycerine volatilized is much greater than if exploded, and consequently the

effects far more deleterious. I have witnessed a whole "shift" "knocked out" from this cause.

Of course, such measures as are generally used in cases of asphyxia are of service. But in addition to these, the use of cold to the head, and of atropine, ergotine, or other vaso-motor stimulants, administered subcutaneously, are of necessity indicated and exceedingly efficacious. There is little doubt that the effects of nitro glycerine are produced from its decomposition and the formation of a nitrite in the body. "Treatment with ammonia restores normal color and normal functional power to nitrite-poisoned blood."

Acting on this principle, and from its stimulant properties, I have uniformly treated my cases with inhalation of ammonia, and also given the carbonate and aromatic spirits of ammonia internally; and up to the present time have not lost a case.

It seems to me it would be well for those in charge of such works to recommend to the workmen to carry with them small vials of this remedy for use in similar cases.

In none of the cases did I notice any changes in the blood—that is, darkening—such as are mentioned in nitro-glycerine poisoning, but this may have been due to lack of proper observation on my part. In numerous cases of pneumonia the sputum was darker than usual, but this I attributed to the dust and lamp-smoke inhaled.

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